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## Downturn in Hip Fracture Incidence

### SYNOPSIS

ALTHOUGH THERE WAS evidence of a decline in hip fracture incidence in the northern United States between 1984 and 1987, most historical data in the United States and Northern Europe indicate that the age-adjusted incidence is rising. Analysis of data from Rochester, MN, from 1928 to 1992 demonstrates that age-adjusted hip fracture incidence rates rose in women from 1928 to 1950, and in men from 1928 to 1980, with falling rates thereafter. These trends were accounted for by initial hip fractures due to moderate trauma in the oldest age groups. Current data from this population show decreased incidence rates within 10% of the goals outlined in "Healthy People 2000," especially among women. A better understanding of the reasons for the decline of hip fracture incidence in Rochester, MN, may provide the basis for more focused interventions in similar populations.

**T**he impact of osteoporosis on society, in terms of mortality, functional dependence, and cost, is attributable in large measure to hip fractures. There were some 300,000 hip fractures in the United States in 1991, and almost a quarter of these elderly persons die within a year.<sup>1</sup> About 10% of survivors become functionally dependent as a result of the hip fracture,<sup>2</sup> and expenditures for the care of these patients have been estimated at nearly \$9 billion annually in the United States.<sup>3</sup> These costs are expected to rise in the future because hip fracture incidence rates increase exponentially with aging. With the elderly population growing rapidly,<sup>4</sup> we may see as many as 840,000 hip fractures annually in the United States by the year 2040.<sup>5</sup>

Thus, it is understandable that "Healthy People 2000" goals include a reduction in hip fracture incidence among elderly Americans from a rate of 714 per 100,000 in 1988 to 607 per 100,000 by the year 2000. Most important are reductions in the high-risk target population of white women ages 85 and older from a baseline rate of 2721 per 100,000 to 2177 per 100,000.<sup>6</sup>

Age-adjusted hip fracture incidence rates are increasing in many regions of the world,<sup>7</sup> however, and rising rates were also reported for the United States between 1970 and 1983.<sup>8</sup> A true increase in hip fracture incidence would make it difficult to achieve the "Healthy People 2000" targets, but studies based on

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hospital discharge data are subject to a number of inaccuracies,<sup>7</sup> and more recent data would be of interest.

Consequently, we updated an earlier study of hip fracture incidence in Rochester, Minnesota, for an additional 10 years in order to evaluate trends over the 65-year period of 1928 through 1992.

## Methods

Population-based research is feasible in Rochester because medical care is virtually self-contained within the community and there are relatively few service providers. Most orthopedic care is provided by Mayo Clinic, which has maintained a common medical record with its two affiliated hospitals for more than 85 years.

Recorded diagnoses and surgical procedures are indexed, including the diagnoses made for outpatients, emergency room visits, or nursing home care, as well as the diagnoses recorded for hospital inpatients, at autopsy examinations, and on death certificates.<sup>9</sup> Medical records from other service providers in the community, most notably the Olmsted Medical Group and its affiliated Olmsted Community Hospital, are also indexed and retrievable. Thus, details of the medical care provided to the residents of Rochester are available for study through this medical records linkage system (the Rochester Epidemiology Project). Using this unique database, we identified all proximal femur (hip) fractures that occurred among Rochester residents during the 65-year period of 1928 through 1992.

Almost all of these patients were admitted to local hospitals, but the availability of outpatient data allowed us to identify fractures that occurred elsewhere, such as in nursing home residents who were not hospitalized. Fractures at all proximal femur sites were included except the uncommon isolated fractures of the greater or lesser trochanter. Subtrochanteric fractures and those more distal on the femur were excluded. Radiographic or autopsy confirmation was obtained for all but nine fractures (0.3%), for which a clinical diagnosis alone was accepted.

In calculating incidence rates, the entire population of Rochester or Olmsted County, depending on the analysis, was considered to be at risk. Age- and sex-specific person-years (p-y) were estimated from decennial census data with linear interpolation between census

years.<sup>10</sup> In order to obtain some sense of variability, it was assumed that given a fixed number of person-years, the number of incidence cases follows a Poisson distribution. This allowed for the estimation of standard errors and the calculation of confidence intervals for the incidence rates. Overall rates were directly adjusted for age and age-sex to the population distribution of U.S. whites in 1990. The standard errors or confidence intervals of the adjusted rates are based on the same assumptions.

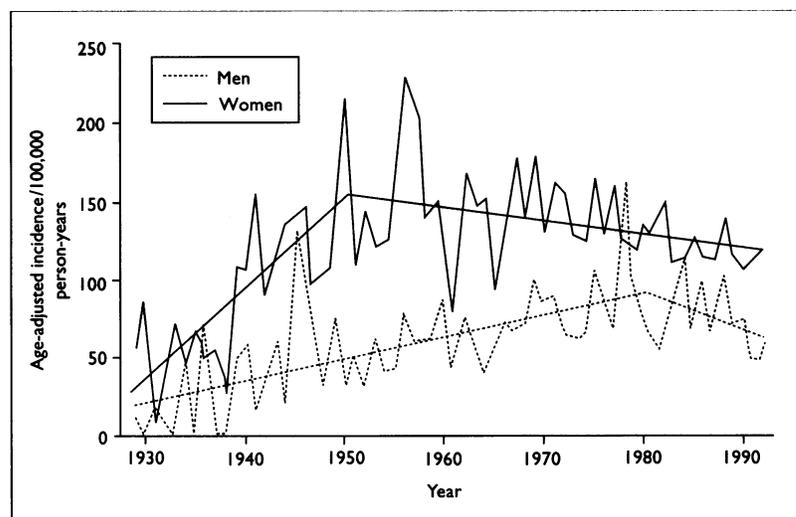
The relationships of crude incidence rates to age, sex, and year of fracture were assessed using generalized linear models assuming a Poisson error structure.<sup>11</sup> These models fit the natural logarithms of the crude incidence rates as linear combinations of sex, age, and the year of fracture using the SAS procedure, GENMOD. Changes in age or age-sex adjusted rates were evaluated using least squares regression analysis.<sup>12</sup> The slope was allowed to change at the "best" year knot, based on a systematic examination of all year knots.

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## Results

During the 65-year study period, 2221 Rochester residents experienced 2454 proximal femur fractures. There was considerable variation in the annual incidence rates, especially in the early years when the number of cases was small. But curve-smoothing techniques reveal a steady rise in age-adjusted incidence rates among men of about 1.5 per

**Figure 1. Age-adjusted incidence of all hip fractures among Rochester, Minnesota women and men by year, 1928–92, showing estimated trends by regression analysis.**



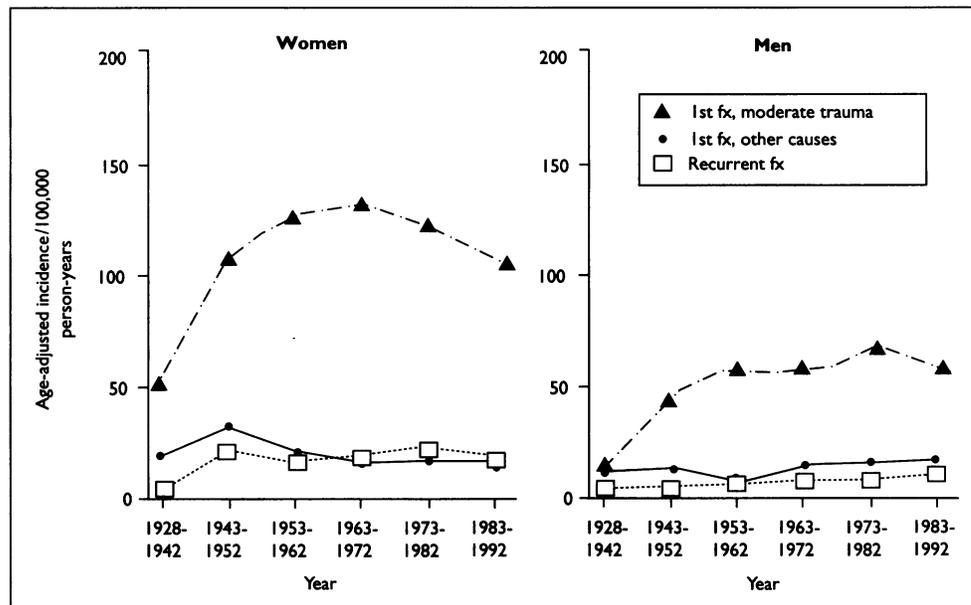
100,000 p-y per year ( $P < 0.001$ ) between 1928 and 1980 as shown in Figure 1. There is some evidence of a decline in rates subsequently ( $P = 0.047$ ). The pattern is different among women, where rates rose dramatically between 1928 and 1950 only to decline thereafter (Figure 1). Over the past 20 years (1963 through 1992), the age-adjusted incidence among women has fallen at about 1.9 per 100,000 p-y per year ( $P < 0.001$ ). Consequently, the female-to-male ratio of age-adjusted incidence rates fell from 2.8 to 1 in the 1933-42 period to 1.5 to 1 in 1983-92.

Of the 2454 hip fractures observed during the study period, 2179 (89%) represented the first one that the patient had experienced, while 275 were recurrent fractures. There was little change in the per capita incidence of recurrent hip fractures over the last 40 years, and the overall temporal pattern was entirely accounted for by changes in the incidence of first fractures (Figure 2). Indeed, the overall pattern was the result of changes in the incidence of first fractures due to moderate trauma (that is, falls from a standing height or less). There was little change in the incidence of first hip fractures due to other causes, including high energy trauma (such as motor vehicle accidents and falls from heights) or localized pathology, which altogether comprised 15% of total fractures. Age-specific rates for first fractures due to moderate trauma are shown separately for women and men in Figure 3. Among both men and women, incidence rates rose with age, but the time trends were most evident among women ages 75 and older and men ages 85 and older.

### Discussion

Previous reports indicated that annual hospital discharges for hip fractures in this country increased at a rate of 1.8 per 100,000 per year for white women ages 45 and older

**Figure 2. Age-adjusted incidence of first hip fractures due to moderate trauma or to other causes and recurrent hip fractures among Rochester, Minnesota women and men by time period, 1928-92.**



( $P = 0.06$ ), and 2.0 per 100,000 per year for white men ( $P = 0.002$ ) between 1970 and 1983. Increases for women and men of other races were not statistically significant.<sup>8</sup>

Comparable data from Saskatchewan and Manitoba, Canada, indicate that annual discharge rates rose by 2.1 per 100,000 per year for women and 1.8 per 100,000 per year for men ages 50 and older between 1972 and 1984.<sup>13</sup> These studies were potentially biased because fracture etiology was

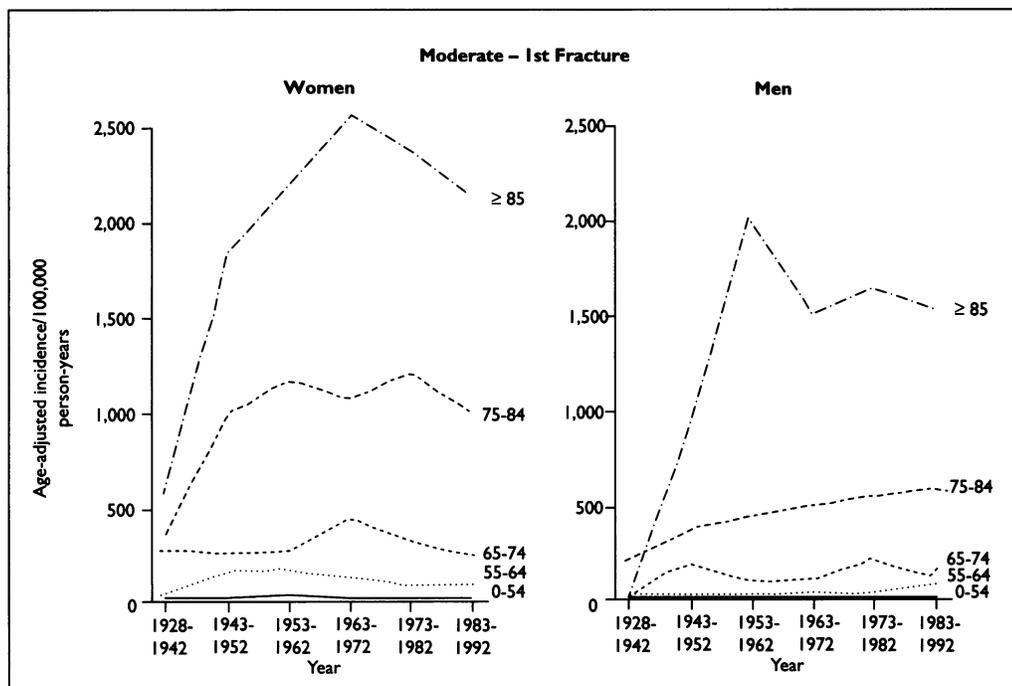
unknown, initial hip fractures could not be reliably distinguished from subsequent ones, and people may have been counted more than once because of interhospital transfers. In addition, it was found in Saskatchewan that hip fracture incidence was overestimated by about 5% because of the inclusion of patients admitted for other fractures or for retreatment of a previous hip fracture, and potentially underestimated by about 7% as a result of

missing cases of pathologic or multiple fractures, or hip fractures inadvertently coded to another skeletal site.<sup>14</sup>

Biased case ascertainment is also a problem in the United States. Up to 6% of hip fracture cases may go unreported in Medicare hospitalization data.<sup>15</sup> These biases were overcome in the earlier population-based study in

Unfortunately, it is not possible to specify the means by which hip fracture rates have fallen in this community to approach the year 2000 health objectives.

**Figure 3. Age-specific incidence of first hip fractures due to moderate trauma among Rochester, Minnesota women and men by time period, 1928–92.**



Rochester,<sup>7</sup> but the result for men was almost the same as in the previous reports, with hip fracture incidence rates increasing by 1.4 per 100,000 person-years per year between 1928 and 1982.<sup>7</sup> Indeed, the age-adjusted incidence of hip fractures has been rising among men at about the same rate everywhere in the world,<sup>7</sup> and the present study is the first to show any persistent downturn in these rates.

The age-adjusted incidence of hip fractures among Rochester women, on the other hand, increased dramatically between 1928 and 1950 before beginning a slow decline. The dramatic rise in hip fracture incidence among Rochester women in the first half of the century was originally attributed to better diagnosis associated with introduction of the first effective treatment, hip-pinning, in the mid-1930s.<sup>16</sup>

Steep increases in incidence in other regions of the world in the 1960s and 1970s,<sup>7</sup> however, indicate that real changes have taken place that must reflect the action of some etiologic factor. Attempts have been made to explain these trends on the basis of increased life expectancy with a greater prevalence of frail elderly, decreased physical activity as a consequence of industrialization and improved transportation, changes in diet and consumption of cigarettes and alcoholic beverages, altered patterns of oophorectomy and hormone replacement therapy, and so on.<sup>17,18</sup> However,

there is no credible explanation for falling incidence rates among women.

what in the final four years of study.<sup>20</sup> There is also evidence that hip fracture incidence rates in the United States declined between 1984 and 1987 among elderly white women residing north of latitude 45°, which includes Minnesota.<sup>21</sup>

The historical data we analyzed are available only for Rochester, the centrally located urban center of Olmsted County, Minnesota. From 1980 onward, however, hip fracture incidence rates are available from the entire county, the population of which is largely white (96% in 1990), better educated than United States whites in general, and slightly younger, more often employed in the health service industry, and with a somewhat higher median income. Nonetheless, hip fracture incidence rates in the community are quite similar to hospital discharge rates for hip fracture from the country as a whole. Although rates in urban Rochester are 36% greater than those in the surrounding areas of Olmsted County, which is largely rural,<sup>22</sup> the overall composition of the County (66% urban) is about the same as that for United States whites generally (72% urban), and the age- and sex-adjusted incidence rate for those ages 50 and older in Olmsted County (385 per 100,000 person-years in 1985–92; 95% confidence interval of 356–413) is quite similar to that reported for United States whites in this age-group in 1988–89 (394 per

no single explanation appears to account for the different patterns among men and women, nor the timing of rising rates among women in different regions.<sup>7</sup> Age-adjusted rates in women continued to rise in most regions during the 1980s,<sup>7</sup> but there have been other recent reports of moderating or falling rates.

After rising 61% between 1968 and 1978, the age-adjusted incidence of hip fractures stabilized among women in England and Wales between 1979 and 1985.<sup>19</sup> In Malmö, Sweden, age-adjusted rates in women doubled between 1950 and 1987 before declining some-

100,000 per year) when comparably adjusted to 1990 United States whites ages 50 or older.<sup>23</sup>

Based on the most recent three years of data, the incidence of hip fractures among Olmsted County women ages 85 and older is 2258 per 100,000 person-years, or within 4% of the "Healthy People 2000" objective of 2177 per 100,000 for this age group.<sup>6</sup> The 1990–92 rate is 662 per 100,000 person-years for Olmsted County men and women ages 65 and older compared with the target rate in this age-group of 607 per 100,000. Comparable figures for this age group nationally were 757 per 100,000 in 1992 but 841 per 100,000 in 1993.<sup>24</sup>

Unfortunately, it is not possible to specify the means by which hip fracture rates have fallen in this community to approach the year 2000 health objectives. No systematic control or intervention programs for osteoporosis or fractures have been implemented in this population and, although speculation is rife,<sup>17,18</sup> there is no credible explanation for falling incidence rates among women in Rochester or anywhere else.<sup>7</sup> Nevertheless, detailed examination of the most recent national data is needed to determine if these trends are widespread and, if so, to generate additional hypotheses about the factors responsible so they might be exploited in more focused interventions to further reduce this important public health problem.

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